BBC RD 1974/12

RESEARCH DEPARTMENT

REPORT

ACOUSTIC SCALING: the effect on acoustic quality of increasing the height of a model studio

H.D. Harwood, B.Sc.
K.F. Lansdowne

Research Department, Engineering Division
THE BRITISH BROADCASTING CORPORATION March 1974

BBC RD 1974/12
UDC 534.846.6

ACOUSTIC SCALING: THE EFFECT ON ACOUSTIC QUALITY OF INCREASING THE HEIGHT OF A MODEL STUDIO

H.D. Harwood, B.Sc.
K.F. Lansdowne

Summary

The effect on acoustic quality of raising the height of a model studio has been examined. The height was increased in two stages, firstly by 30% and then by a total of 60%. When, in each case, the reverberation time was brought back to its original figure by increasing the absorption, no change in sound quality over that originally obtained was detected when listening to stereo signals obtained by means of a pair of spaced omni-directional microphones. Nevertheless, it must not necessarily be inferred that the same effect would be experienced by a member of a live audience in the real-size studio.

issued under the authority of

P. Lanigan

Head of Research Department

Research Department, Engineering Division,
BRITISH BROADCASTING CORPORATION

March 1974

(PH–123)

ACOUSTIC SCALING: THE EFFECT ON ACOUSTIC QUALITY OF INCREASING THE HEIGHT OF A MODEL STUDIO

ACOUSTIC SCALING: THE EFFECT ON ACOUSTIC QUALITY OF INCREASING THE HEIGHT OF A MODEL STUDIO

H.D. Harwood, B.Sc.
K.F. Lansdowne

1. Introduction

The effect of early reflections on sound quality in a concert hall has been discussed in the literature.[1] The Madia Vale Studio No. 1 used for orchestral music programmes has a relatively low ceiling, the average height to width radio being 1:2.5, and hence the first reflections from a centrally placed sound source come from the ceiling. Some complaints have been made with regard to the sound quality from this studio and the relatively low ceiling was thought to be one possible cause, to the extent that a plan to raise the roof by about 4·5 metres (15 ft.) was considered and costed.

Experiments with a one-eighth scale model of this studio have already been described,[2,3,4] and advantage was taken of the existence of this model to investigate the possible improvements in quality that would be obtained from raising the height of the ceiling, first by the equivalent of 2·42 metres (8 ft.) and then by the equivalent of a total of 4·84 metres (16 ft.), so that the percentage increases in height are nearly thirty percent and sixty percent respectively.

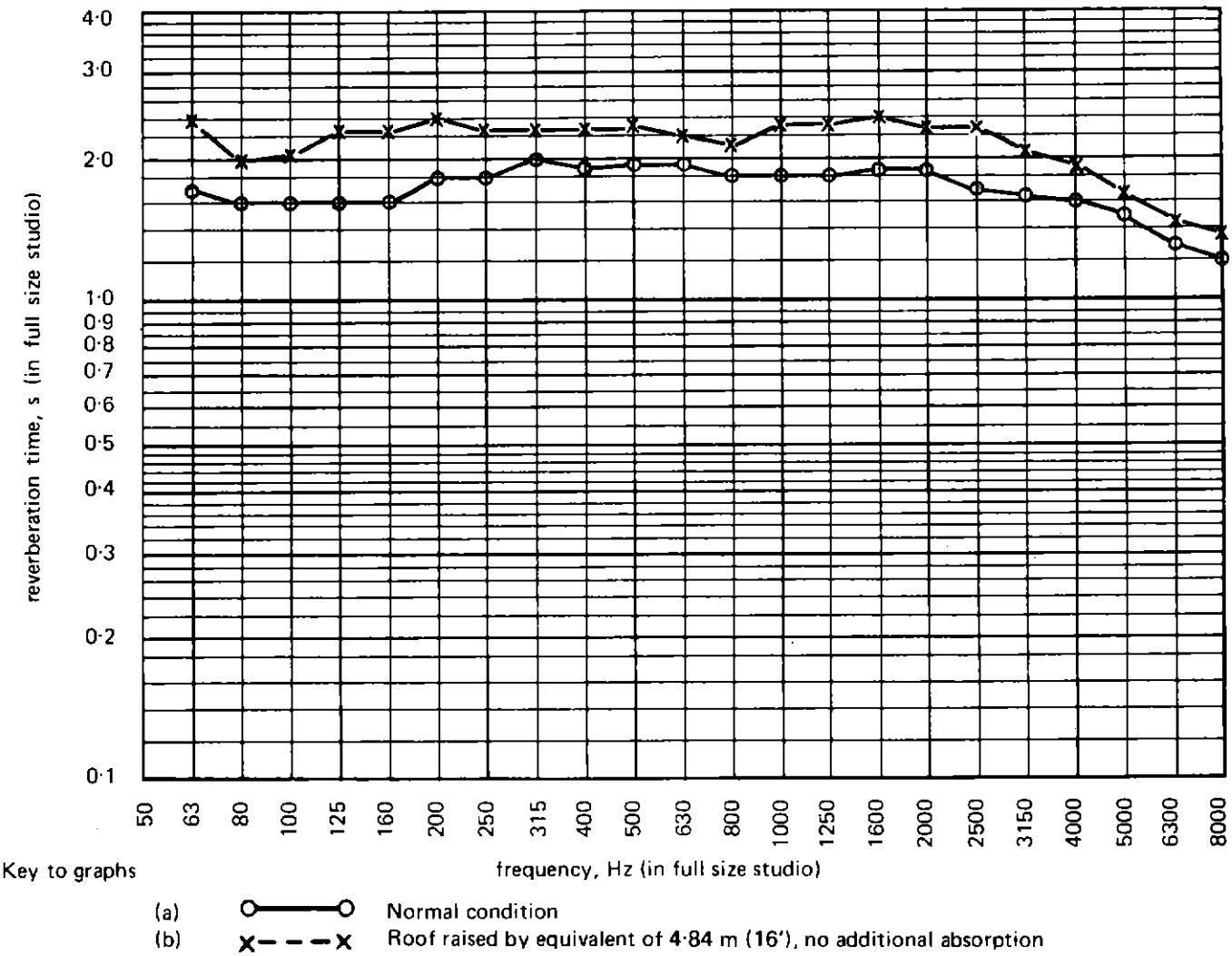

Fig. 1 - Reverberation time/frequency curve of model for two conditions

2. The tests

The acoustical arrangements were similar to those used in earlier experiments; stereophonic signals, including some obtained from recordings of 'dead' music, were scaled up in frequency and radiated by two spaced transducers simulating monitoring loudspeakers. The sound in the model was picked up by a pair of spaced omni-directional microphones whose outputs were scaled down in frequency for listening purposes.

The ceiling was first raised the full amount, i.e. the equivalent of 4·84 metres (16 ft.) and, as expected, this led to an appreciable increase in reverberation time. Curves indicating the reverberation times obtained in the unmodified condition, and with the roof raised the equivalent of 4·84 metres (16 ft.) are shown in Fig. 1, curves (a) and (b) respectively.

Tapes of programme signals recorded with the original and with the increased reverberation times were played back to an audience composed of engineering staff experienced in critical listening. The effect of the increased reverberation time was obvious (it was described as 'instant cathedral') and it was felt that some increase in reverberation time over the original value was desirable; a figure of two seconds was thought to be about optimum, and this opinion was subsequently borne in mind when considering the choice of this parameter for a new large orchestral studio.

It should be noted here that the average figure of 1·8 seconds obtained in the Madia Vale No. 1 Studio is already slightly above the design value suggested by Beranek[5] and Burd et al;[6] the figure of 2 seconds is the value indicated by the latter for studios of about three times the volume of Madia Vale No. 1.

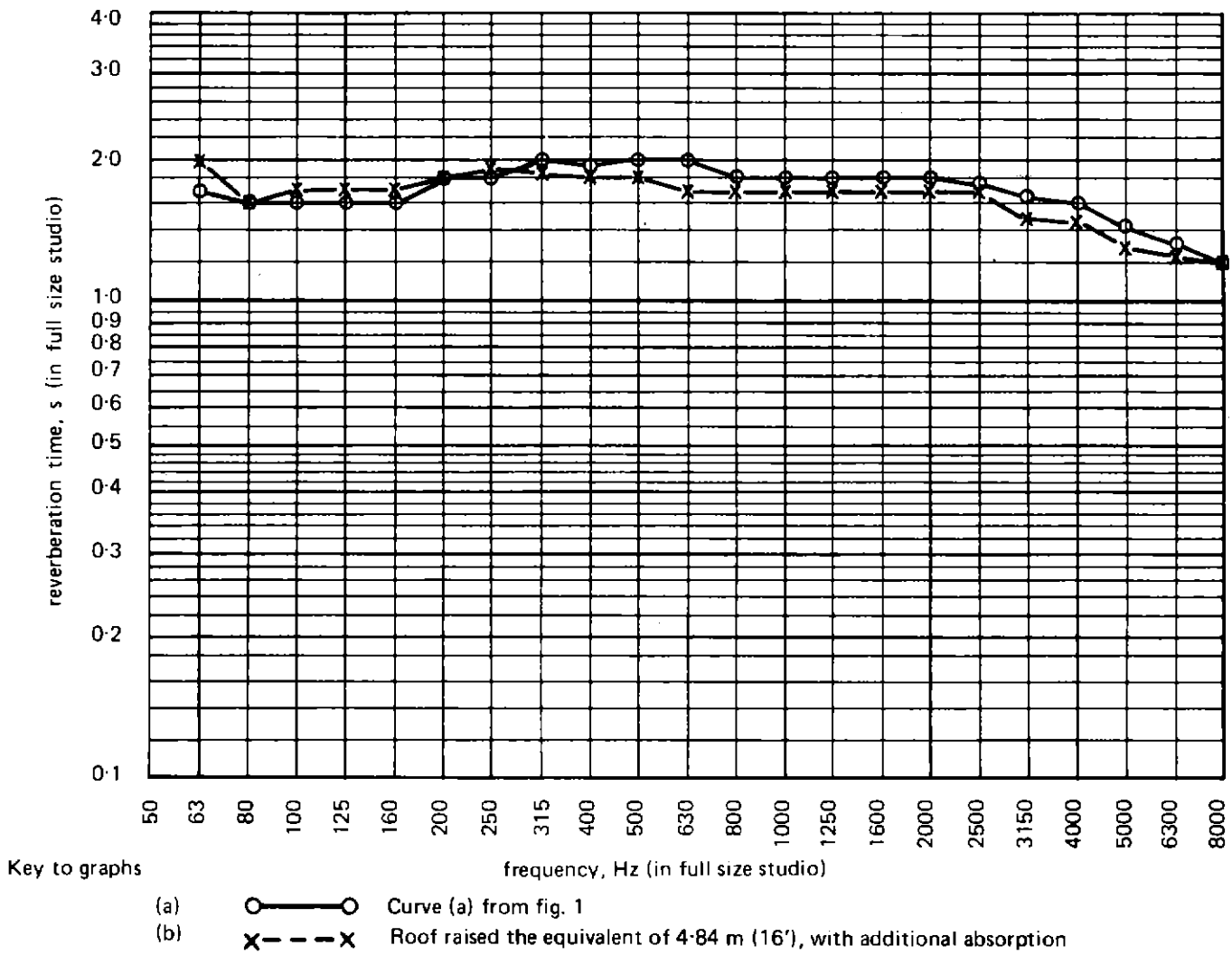

Fig. 2 - Reverberation time/frequency curve of model for two conditions

The model studio was then acoustically treated to reduce the reverberation time to a value as close as *possible to that obtained in the unmodified model.* The reverberation-time/frequency curve obtained is shown in Fig. 2; curve (a) of Fig. 1 is included for comparison.

Further recordings were made using the dead music and these were compared with those obtained from the model in its original condition. Listening tests using the microphone outputs revealed that the sound quality obtained in the former case was indistinguishable from that obtained in the latter and it was impossible to tell which related to the greater ceiling height. In this regard it should be noted that increasing the height must necessarily have affected the early reflections from the roof and that also the addition of acoustic absorbers needed to bring the reverberation time back to its original value must also have influenced the diffusion in the model.

Subsequently, the ceiling in the model was lowered by the equivalent of 2·42 metres (8 ft.) (equivalent to increasing the height of the unmodified real studio by 2·42 metres (8 ft.)) and the reverberation time again adjusted by absorbers to the original value; the reverberation-time/frequency curve obtained under these conditions is shown in Fig. 3, which again includes Fig. 1(a) for comparison. Once again the sound qualities obtained for the two conditions were considered to be identical, thus confirming the previous result.

3. Discussion

When listening to programme sound signals reproduced from two transducers and picked up by two spaced omni-directional microphones it is not possible to detect

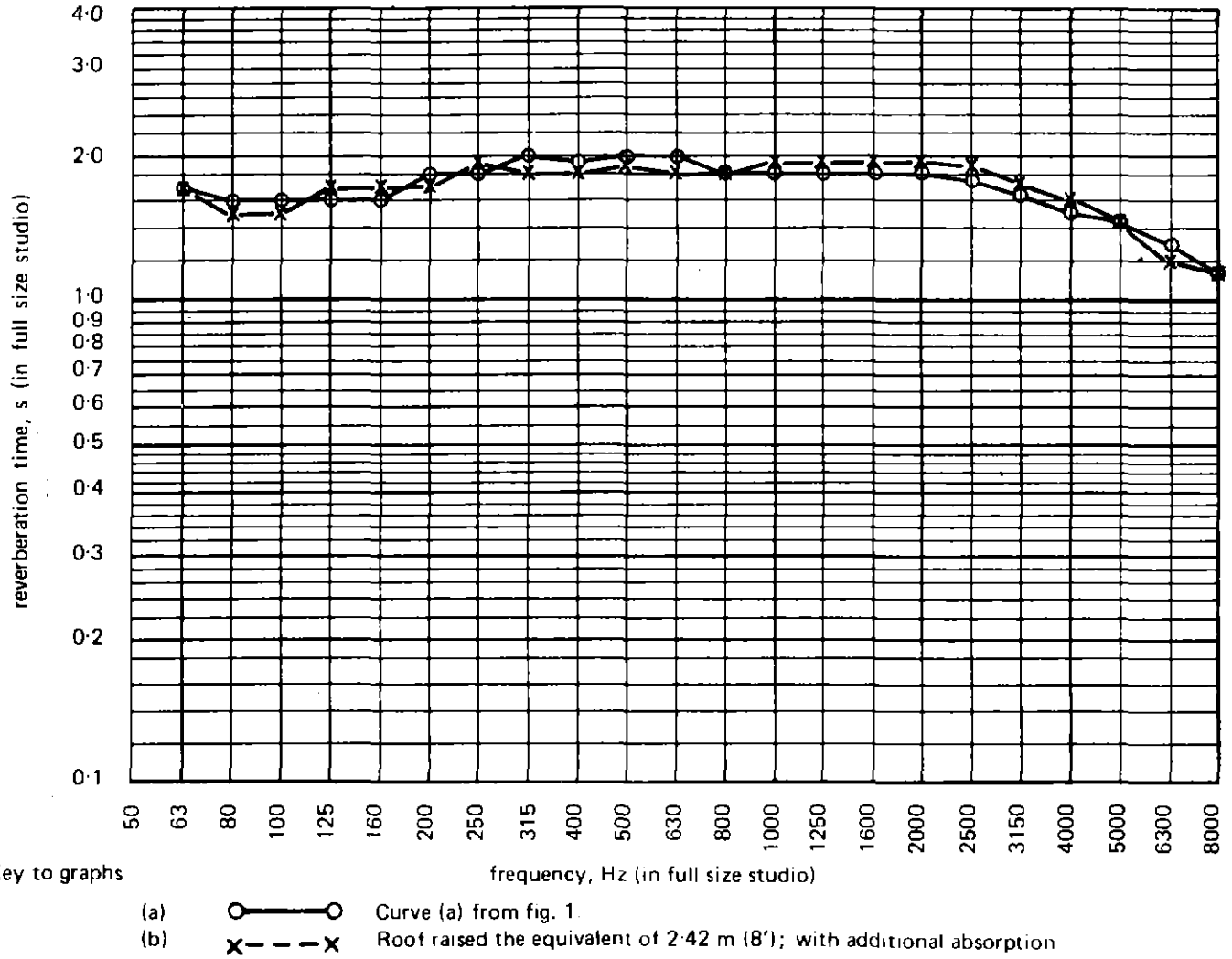

Fig. 3 - Reverberation time/frequency curve of model for two conditions

aurally the effect of raising the height of the model Madia Vale No. 1 Studio by 60% if the reverberation time is made equal to what it was originally. This result is the same as would be heard by listeners to a broadcast programme picked up by either a single microphone (monophonic) or a coincident pair of microphones (stereophonic) and makes the recommendation previously mentioned to increase the height of the studio difficult to justify.

However, it should be emphasised that this result does not necessarily mean that an observer actually in the full size studio would not detect the effect of an increase in height; a single horizontally aligned spaced omnidirectional microphone-pair cannot discriminate in the vertical plane, and further experiments should be carried out using four microphones so that this can be taken into account. Even if this confirms the present findings, there is obviously a limit to which the height of the ceiling can be reduced in practice, one such value being determined by the minimum volume needed to secure the desired reverberation time in the presence of an orchestra.

4. References

1. MARSHALL, A.H. 1966. A note on the importance of cross-section in concert halls. J. Sound & Vibration, 1967, **5**, 1, p. 100 – 112.

2. HARWOOD, H.D. and BURD, A.N. 1970. Acoustic Scaling: General outline. BBC Research Department Report No. 1970/13.

3. HARWOOD, H.D., BURD, A.N. & SPRING, N.F. 1972. Acoustic Scaling: An evaluation of the proving experiment. BBC Research Department Report No. 1972/3.

4. HARWOOD, H.D. *and* LANSDOWNE, K.F.L. 1972. Acoustic Scaling: Instrumentation. BBC Research Department Report No. 1972/34.

5. BERANEK, L.L. 1954. Acoustics. McGraw-Hill, New York, p.425.

6. BURD, A.N., GILFORD, C.L.S. *and* SPRING, N.F. 1966. Data for the acoustic design of studios. BBC Engineering Monograph, 1966, No. 64, fig.6.

Printed by BBC Research Department, Kingswood Warren, Tadworth, Surrey